

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED
M. Sc. INORGANIC CHEMISTRY Second Year
(SEMESTER III & IV)
CBCS Pattern Syllabus
June 2015

Semester	Paper	Course No	Course	Periods/ Week	Total Periods	Credits
Semester III	XV	CH-531	Advanced Spectroscopic Methods	4	60	4
	XVI	CH-532/1	Bio Inorganic and Supramolecular Chemistry	4	60	4
	XVII	CH-533/1	Organo Metallic Chemistry	4	60	4
	XVIII	CH-534/1	Analytical Chemistry	4	60	4
	XIX		Seminar			1
Semester IV	XX	CH-541/1	Organo Metallic catalysis and fluxanality	4	60	4
	XXI	CH-542/1	Photoinorganic chemistry	4	60	4
	XXII	CH-543/1	Chemistry of materials	4	60	4
	XXIII	CH-544/1	Nuclear and Radiation chemistry	4	60	4
	XXIV		Seminar			1
Practicals	XXV	CH-501	Laboratory course V	6	132	4
	XXVI	CH-502	Laboratory course VI	6	132	4
	XXVII	CH-503	Laboratory course VII	6	132	4
	XXVIII	CH-504	Laboratory course VIII	6	132	4

For each paper ESE-75 Marks (3 Credit), CA- 25 Marks (1 Credit)

M. Sc. Second Year, Semester-III
Paper–XV, [CH-531]
Advanced Spectroscopic Methods

Marks: 4 Credits

Periods: 60

SM-1: UV-Vis Spectroscopy:

SM-2: IR spectroscopy:

SM-3: NMR Spectroscopy (Organic):

SM-4: NMR Spectroscopy (Inorganic):

SM-5: Mass Spectroscopy:

SM-6: Moissabaur Spectroscopy:

SM-7: Structural problems:

SM-1: UV-Vis Spectroscopy:

06P

Fieser-Woodward rules for conjugated dienes and carbonyl compounds, Fieser-Kuhn rules for polyenes. UV spectra of aromatic compounds and heteroaromatic compounds. Calculation of λ_{\max} for the benzene derivatives (R-C₆H₄-Co-G) by A. I. Scott empirical rules.

SM-2: IR spectroscopy:

10P

a) Recapitulation, Characteristic vibration frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds Ketones, aldehydes, esters, amides, acids, anhydride, Lactose, lactams and conjugated carbonyl compounds. Factors affecting group frequencies: overtones, combination bands and Fermi-resonance. FTIR and sampling technique.

b) Structural information from vibrational spectra: Group frequencies, Characteristic band stretching frequencies, Mode of vibrations of linear and non-linear molecules, deformation, frequencies of carbonyl metal complexes, pattern of group frequencies, mode of bonding of ambidentate ligands, Cyanides, Ethylenediamine and Diketone complexes.

SM-3: NMR Spectroscopy (Organic):

12P

a) ¹H NMR: General introduction and definitions, Chemical shift, Spin-spin interaction, shielding mechanism of measurement of chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehyde and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides and mercapto). Factors affecting chemical shift. Deuterium exchange. Spin-spin coupling, factors affecting coupling constant. Complex spin-spin interaction between two and three nuclei. Simplification of complex spectra, nuclear magnetic double resonance, contact shift reagents, solvent effects. Fourier transform technique. Nuclear Over-Hauser effect (NOE). Resonance of other nuclei; ¹⁹F and ³¹P.

b) ¹³C NMR: Resolution and multiplicity of ¹³C NMR, ¹H-decoupling, noise decoupling, broad band decoupling; Deuterium, fluorine and phosphorus coupling; NOE signal enhancement, off-resonance, proton decoupling, Structural applications of CMR. DEPT; Introduction to 2D-NMR: COSY, NOESY, DEPT, INPET, APT, INADEQUATE.

3

SM-4: NMR Spectroscopy (Inorganic):

08P

a) Basic principle of NMR spectroscopy and applications to Paramagnetic compounds and metal nuclei of Pt ¹⁹⁵ and Sn ¹¹⁹.

b) Basic principle and applications of ESR spectroscopy to different free radical

molecules and transition metal ion complexes.

SM-5: Mass Spectroscopy:

06P

Theory, instrumentation and modifications; Unit mass and molecular ions; Important terms- singly and doubly charged ions, metastable peak, base peak, isotropic mass peaks, relative intensity, FTMS, etc.; Recognition of M⁺ ion peak; General fragmentation rules: Fragmentation of various classes of organic molecules, including compounds containing oxygen, sulphur, nitrogen and halogens; α-, β-, allylic and benzylic cleavage; McLafferty rearrangement.

SM-6: Moissabaur Spectroscopy:

08P

Basic principle of Moissabaur Spectroscopy, applications on the basis of isomer shifts, electric quadrupole interactions. Elucidation of structure of I₂Br₂Cl₄, I₂Cl₆, Fe⁺² and Fe⁺³ complexes and Sn⁺² and Sn⁺⁴ compounds

SM-7: Structural problems:

10P

a) Combined problems on UV, IR, NMR and Mass spectral data for structure determination.

b) Elucidation of structure of organic molecules using spectra (IR & NMR).

Reference Books:

1. Spectroscopic identification of Organic Compounds, R. M. Silverstern, G. C. Bassler and T. C. Morril.
2. Introduction to NMR spectroscopy, R. J. Abraham, J. Fisher and P. Loftus.
3. Application of spectroscopy of organic compounds – J. R. Dyer.
4. Spectroscopy of organic compounds, P. S. Kalsi.
5. Organic Spectroscopy, William Kamp.
6. Organic Chemistry, R. T. Morrison and R. N. Boyd.
7. Practical NMR spectroscopy, M. L. Martin, J. J. Delpenach and G. J. Martin.
8. Spectroscopic methods in organic Chemistry, D. H. William, I. Fleming.
9. Fundamentals of Molecular spectroscopy – C.N.Banwel

M. Sc. Second Year, Semester-III
Paper–XVI, [CH-532/1]
Bioinorganic and Supramolecular Chemistry

Marks: 4 Credits

Periods:60

Bioinorganic chemistry

1. Introduction, Role of metals and non-metals in biological systems

05P

2. Metal storage and transport

15P

a. Alkali and Alkaline Earth metals: Na/K pump, Ca pump, transport of Ca⁺⁺ in microbes.

b. Supply and storage of iron: Ferritin, transferrin and siderophores

c. Storage and transport of copper and zinc

d. Transport and storage of other metals

3. Transport and storage proteins

10P

Oxygen transport and storage: Oxygen carrier, myoglobin and haemoglobin, Hemerythrin and Hemocyanin

4. Metals in medicines

08P

Metals and its complexes as a therapeutic agents

i. Anti cancer drugs (Platinum and other metal complexes) ,

ii. Antiarthralgic Drugs (Gold and copper complexes)

iii. Metal deficiency : Iron, Copper, Zinc, Cobalt, and other metal toxicity

iv. Vitamin B₁₂.

Supramolecular chemistry

1. Concept and language :

08P

Molecular recognition : Molecular receptors for different types of molecules including anionic substrates, design and synthesis of coreceptor molecules and multiple recognition.

2. Supra molecular reactivity and catalysis

08P

Anion receptor molecules, metallo receptor molecules and co-catalysis

3. Supra molecular assemblies

06P

Molecular and supramolecular photonic/ electronic/ionic devices

Books Suggested

1. Principles of bioinorganic chemistry, S. J. Lipard and J. M. Berg University science book

2. Bioinorganic Chemistry , I.Bertine, H.B.Grey, S.J.Lipard, University Science book

3. Progress in Inorganic Chemistry – Vol. 18 & 38 Edn J.J.Lipard Wiley

4. Supra molecular chemistry, J.M.Lehn, VCH

5. Bioinorganic and supramolecular chemistry, Ajay kumar Bhagi and G.R.Chatwal , Himalaya Publication.

Paper–XVII, [CH-533/1]
Organo-metallic Chemistry

Marks: 4 Credits

Periods: 60

1. Organometallic Chemistry

12P

- a. Introduction, Classification, Nomenclature, 18 electron rule and their stability.
- b. Synthesis and properties of organometallic compounds with i. carbonyl, ii. Phosphine, iii. Nitrosyl ligand

2. Compound of transition metal carbon multiple bonds

16P

Introduction, Synthesis, Nature of bonds, structural characteristic, Nucleophilic and Electrophilic reactions on the ligands, Role in organic synthesis of i. Transition metal Fischer and Schrock carbene complexes. ii. Transition metal alkylidyne complexes.

3. Transition metal π complexes

20P

- a. Introduction, Transition metal π complexes with unsaturated organic molecules,
- b. Preparations, properties, nature of bonding and structural features. Important reaction relating to nucleophilic and electrophilic attack on ligand and to organic synthesis.
 - i. Transition metal Alkenes complexes,
 - ii. Transition metal Alkynes complexes,
 - iii. Transition metal Allyl complexes,
 - iv. Butadiene Transition metal cyclobutadiene complexes,
 - v. Transition metal cyclopentadienyl complexes,
 - vi. Transition metal Arene complexes,
 - vii. Transition metal trienyl complexes,

4. Reactions of Organometallic compounds

12P

- a. Oxidative - addition reactions,
- b. Reductive elimination reactions,
- c. Insertion reactions
- d. Deinsertion reactions,
- e. Nucleophilic and Electrophilic attack on coordinated ligand

Books Suggested

1. Principles and Applications of organotransition metal chemistry
J.P.Collman, L.S.Hagsdus J.R.Norton & R.G.Finke – University science book.
2. Organometallic chemistry of transition metal – R.H.Carbete, John Wiley
3. Metalloorganic chemistry – A.J.Pearson – Wiley
4. Organometallic Chemistry – R.C.Mehrotra A.Singh – Sage International
5. Inorganic Chemistry by Butler, Harrod, 1989, Benjamin/Cummins Pub.Co.

M. Sc. Second Year, Semester-III
Paper–XVIII, [CH-534/1]
Analytical Chemistry

Marks: 4 Credits

Periods: 60

1. Thermal methods of analysis

15P

Introduction of different thermal methods, Thermogravimetry TG, and DTG, Static thermogravimetry, quasistatic, Thermogravimetry and dynamic thermogravimetry, Instrumentation Factors affecting thermograms, Applications of thermogravimetry, Differential thermal analysis (DTA), DTA curves, Factors affecting DTA curves, instrumentation, applications of DTA. Simple numerical problems.

2. Electroanalytical Techniques

12P

Voltametry and Amperometry :

Linear and cyclic sweep voltametry, Randle's Sevcik equation, Tests for electrode reactions coupled with chemical reactions coupled, EC and ECE reactions, Application of voltametry in the study of unstable reaction intermediate, Enzyme catalysed reaction.

Stripping technique :

Anodic and cathodic stripping voltametry and their application in the trace determination metal ions and biologically important compounds.

Principal, methodology and applications of amperometric titrations, Chromopotentiometry.

3. Analysis of water pollution

15P

Origin of waste water, Types of water pollutant and their effects. Sources of water pollution – Domestic, Industrial, Agricultural soil and Radioactive waste as a source of pollution. Objective of analysis parameter for analysis colour, Turbidity, total solid, conductivity, acidity, Alkalinity, hardness, chloride, sulphate, fluoride, silica, phosphates and different forms of nitrogen. General survey of instrumental technique for the analysis of heavy metal in aqueous systems. Measurements of DO, BOD and COD. Pesticides as water pollutant and analysis. Water pollution laws and standards

4. Analysis of soils, fuel, Body fluids and Drugs

12P

a. Analysis of soil : Moisture, Ph, total nitrogen, phosphorous, silica, lime, magnesia, manganese, sulphur and alkali salts

b. Fuel analysis : solid, liquid and gas ultimate and proximate analysis – heating values, grinding of coal, liquid fuels – flash points, aniline point, octane number and carbon residue. Gaseous fuels – producer gas and water gas, calorific values

c. Clinical chemistry : Compositions of blood – collection and preservation of samples, clinical analysis, serum electrolysis, blood glucose, blood urea nitrogen, uric acid, albumin, globulins, barbiturates, acid and alkaline phosphates

d. Drug analysis : Narcotics and Dangerous drugs. Classification of drugs, screening by gas and by TLC and spectrophotometric measurements.

5. Food Analysis

06P

- a. Introduction, food safety and reasons
- b. Analysis of food materials: Moisture, ash, crude fibers, fats, proteins, carbohydrates, total sugars, starch, Ca, Na, adulterants.
- c. Microscopic examinations of foods

Books Suggested:

1. Analytical Chemistry – G. D. Christians, J. Wiley
2. Fundamentals of analytical Chemistry – D. a. Smog, C. n. west and F. J. Holler, W. B. Saunders
3. Analytical Chemistry, principles, J. H. Kenedy, W. B, Saunders
4. Principles of Instrumental Analysis, D. A. Skoog, W. B. Saunders
5. Basic concepts of analytical. Chemistry – S. M. Khopkar, wiley Eastern
6. Quantitative analysis – R. A. Day, Jr and A. L. Underwood, Prentice Hall
7. Analytical Chemistry – Alka Gupta, Pragati prakashan.

Paper-XX, [CH-541/1]
Organometallic Catalysis and fluxanality

Marks: 4 Credits

Periods: 60

1. Catalysis

03P

General principles .description and property of catalysts.

Types of catalysts catalytic steps involved in homogenous catalysis and heterogenous catalysis

2. Homogenous catalysis – I

15P

a. General features, types of catalysts

b. Study of

i. Hydrogenation of catalysis (**Wilkinson's catalyst**)

ii. Tolmen catalytic cycle

iii. Monsoanto acetic acid synthesis

iv. Wacker process

v. Ziegler-Natta polymerisation of alkenes

vi. Hydrocarbonylation / Hydroformulation of Olefins

3. Homogenous catalysis – II

15P

Study of

i. Water gas shift reactions

ii. Fishcher-Tropsch synthesis

iii. Hydrosilation

iv. Activation of C-H bond

v. Reppe's catalysis

vi. Heck reactions, Suzuki coupling

vii. Epoxidation

4. Heterogenous catalysis

15P

a. General features, types of catalysts.

b The nature of heterogenous catalysis

i] surface area and porosity

ii] surface acidic and basic sites

iii] surface metal sites

c. Catalytic steps

I] Chemisorption and desorption,

ii] surface migration

d] catalytic reactions

i] hydrogenation of alkenes

ii] Birch clemmenson's reactions

iii] Wolf-kishner reactions

iv] sodium borohydride

v] lithium aluminium hydride

vii] ammonia synthesis

viii] SO₂ oxidation

ix]. Zeolites Synthesis of different zeolites, characterization, synthetic and selective

applications. interconversion of aromatics by zeolites e]Electrocatalysis

5. Fluxional organometallic compounds

12P

- i. Introduction, Detection of stereochemical non-rigidity, Rate of fluxionality
- ii. Fluxionality in trigonal bipyramidal complex.
- iii. Fluxionality in η^3 allyl complex
- iv. Fluxionality in cyclopentadienyl complex

Books Suggested

1. Principles and Applications of organotransitions metal chemistry
J.P.Collman, L.S.Hagsdus J.R.Norton & R.G.Finke – University science book.
2. Organometallic chemistry of transition metal – R.H.Carbete , John Wiley
3. Metalloorganic chemistrty – A.J.Pearson – Wiley
4. Organmometallic Chemistry – R.C.Mehrotra A.Singhj –age International
5. Inorganic Chemistry by Butler, Harrod,1989, Benjamin/Cummins Pub.Co.

**Paper–XXI, [CH-542/1]
Photo Inorganic Chemistry**

Marks: 4 Credits

Periods: 60

1. Basic Photochemistry

15P

- a. Absorption, excitation, photochemical laws, quantum yield.
- b. Readeation, Absorption and emission for complexes with different ground state / excited state for ML_6 complexes.
- c. Potential energy function and energy levels for electronically transition of ML_6 complexes.
- d. Flash photolysis, stopped flow techniques. Energy dissipation by radiative and non-radiative processes, absorption spectra.
- e. Frank-Codon principle, photochemical stages – primary and secondary processes.
- f. Jablonski diagram for photochemical process

2. Photochemical properties of transition metal complexes

15P

- a. Photophysical process
- b. Photochemical process : Photo substitution reactions ,photoredox reactions, Photorearrangement reaction,
- c. Prompt and Delayed Photochemical reactions
- d. Photolysis rules and ligand field theory

3. Photochemical reaction of coordination compounds

15P

- a. Ligand field excited states i) Cr^{+++} ion complexes , Co^{+++} ion complexes, Rh^{+++} ion complexes and Ir^{+++} ion complexes.
- b. charge transfer excited states i) LMCT ii) MLCT iii) Charge transfer to solvent state.
- c. Integrated excited state

4. Photoreactions

15P

- i) In solar energy conversion
- ii) Photographic systems
- iii) photosynthesis

Boks Suggested

1. Progress in Inorganic Chemistry – Vol. 18 & 38 Edn J.J.Lipard Wiley
2. Supra molecular chemistry, J.M.Lehn, VCH
3. Concepts of Inorganic Photochemistry, A.W.Adamson, & T.D.Flkeischaue, Wiley
4. Elements of Inorganic photochemistry – G.J.Ferraudi

**Paper–XXII, [CH-543/1]
Chemistry of Materials**

Marks: 4 Credits

Periods: 60

1. The structure of crystalline solids

10P

- a. Crystal structure: Fundamentals concepts, Unit cells, Metallic structure, Crystallographic points, Directions and planes.
- b. Crystalline and noncrystalline materials: single crystal, poly crystalline materials, and non crystalline solids
- c. Imperfections and related phenomenon in solids

2. Mechanical properties of metals

07P

- a. Elastic deformation and Elastic properties of materials
- b. Plastic deformation and their tensile properties

3. Multiphase materials

12P

Types of metal alloys

- a. Ferrous alloys, Fe-C phase transformation in ferrous alloys, stainless steel, properties of ferrous alloys and their application.
- b. Non-ferrous alloys (compositions and applications of alloys of copper and Aluminum)
- c. Fabrication of metals
- d. Thermal processing of metals

4. Structure, properties and applications of ceramics

10P

- a.** Ceramics structures, mechanical properties,
- b.** Types and applications of ceramics : Glasses and Glass ceramics , clay products. Refractories, abrasives, cements and advanced ceramics.
- c.** Fabrication and processing of glasses and clay products.

5. Composites

06P

- a. Introduction , Scheme for the various composites types
- b. Particle Reinforced composites : concrete
- c. Fibre Reinforced composites , Elastic behaviors
- d.** Ceramic matrix composites.

6. Nanomaterials

15P

- a. Introduction
- b. Basic aspects, properties and application with respect to
 - i. Electronic and optical materials
 - ii. Magnetic properties
 - iii. Superconducting materials
 - iv. Biomaterials
- c.** Thin films and Langmuir-Blodgett films
Preparation technique, evaporation /sputtering chemical processes, MOCVD, solgel etc. Langmuir-Blodgett, film growth technique photolithography

Books Suggested

1. Solid state Physics – N.W.Aschroff G.N.D.Merimin – Saunders college
2. Material science of Engineering, an Introduction – W.D.Callister, Wiley
3. Material science – J.C.Anderson, K.R.laever, J.M.Alexander- ELBS
4. Hand book of liquid crystals – Kaelkar & Haatz, Chemie Verlag
5. Thermotropic liquid crystals, Ed.G.W.Cray, John Wiley
6. Solid state chemistry , N.B. Hannay
7. Principals of Solid state, H.V. Keer.
8. Electronic structures and chemicals solids, P.A. Cox.

**Paper–XXIII, [CH-544/1]
Nuclear and Radiochemistry**

Marks: 4 Credits

**Periods: 60
12P**

1. Radioactivity

- a. Radioactive elements , Characteristics of Radioactive decay
- b. Systematic alpha, Beta, Gamma decays
 - i. Alpha decays, energy curves, Alfa particle energy spectrum, GN law, Theory of alpha decays
 - ii. Types of Beta decays, Electron capture reaction, Range of energy relation ship of beta particle, beta positive decays, Dirac’s theory of positron.
 - iii. Gamma emission, gamma decays constant, internal conversions, Auger effect.

2. Nuclear reactions :

10P

- a. Types and conservation of nuclear reactions,
- b. Reaction cross sections, Energetic, cross sections
- c. Compound nucleus theory of nuclear reactions
- d. Nuclear fission : Mass, energy and charge distribution of fission products, Decay chains,
- f. Fusion reactors

3. Nuclear models

10P

- a. Nuclear stability ,Shell model, Fermi gas model, collective nuclear model and optical model
- b. Nuclear fission : liquid drop model, fission barrier, fission cross section, Mass energy, Symmetric and asymmetric fission

4. Nuclear reactors

10P

Nuclear fission as a source of energy and chain reacting system
Natural uranium reactors
classification of reactors
Critical size of the thermal reactors and its controls
Breeder reactor
Enriched aqueous homogeneous reactors
Reactors in India: Uranium and Thorium recourses,
Reprocessing of spent fuels.

5. Chemicals Effects of Nuclear Transformation

08P

Szillard-Chalmer’s reaction and recoil chemistry, retention
Chemical affects accompanying the other nuclear reactions

6. Radiolysis:

10P

- a. Radiation chemistry
- b. Interaction of radiation with matter
- c. Radiation Dosimetry
- d. Radiolysis of water
- e. Radiolysis of aqueous solutions containing organic and inorganic species
- f. Hydrated electron

Books Suggested:

1. Essentials of Nuclear Chemistry by H.J.Amikal, Wiley Eastern Pvt. Ltd, News Delhi (1990)
2. Source of Book of Atomic Energy, by S.Glasstone, Affiliated East We3st Press ltd., New Delhi (1967)
3. Nuclear chemistry by U.N.Dash, Sultan Chand and soins, Nes Delhiu (1991)
4. Introduction to Radiation chemistry, by J.W.t.Spinks, anmd R.j.Woods, John-Wiley and Sons, New York (1964)
5. Nuclear and radiation Chemistry by B.K.Sharma. Goel Publishing House, Meerut (1997)

M. Sc. Second Year
Laboratory Course-V, Paper– XXV, CH-501/1

Marks: 4 Credits

Periods: 132

Preparations and Characterisation (Any Six)
(Conductance, Magnetic susceptibility, moisture)

1. Metal oxalate hydrate (Mg^{+2})
2. Sodium tetrionate $Na_2S_4O_6$
3. Metal complexes of $CuCl_2 \cdot 2DMSO$
4. $Ni(acac)_2$
5. Bromination of $Ni(acac)_3$
6. Cis/trans $[Co(en)_2Cl_2]^+$
7. $[Co(phenanthroline)-5,6 \text{ quinone}]$
8. Ferrocene
9. Copper glycine complex (Cis/trans)
10. Hexa ammine Cobaltic complex

Estimations

A. volumetric / gravimetric

1. Estimation of Mg^{++} from metal oxalate hydrate complex by volumetric methods
2. Estimation of Tin from Tin halide by Gravimetric methods
3. Estimations of copper from copper DMSO complex by volumetric
4. Estimation of Nickel from $Ni(acac)_2$ by Gravimetric
5. Estimation of chromium from $Cr(acac)_3$ by volumetric methods
6. Estimation of cobalt from $[Co(en)_2Cl_2]^+$
7. Estimation of Iron from Fe(II) chloride by volumetric methods

Laboratory Course-VI, Paper– XXVI, CH-502/1

Marks: 4 Credits

Periods: 132

Instrumentation

A. Spectrophotometry (Any five)

1. Simultaneous determination
 - i] Manganese / Chromium in steel
 - ii] Vanadium and titanium
 - iii] Chromium and cobalt
2. Determination of Nickel by spectrophotometric methods
3. Determination of Tungstan by Spectrophotometric method
4. Determination of Fluoride by Spectrophotometer
5. Job-method Zirconium Alizarin red – 5-complex (mole-ratio method)
6. Stoichiometry and stability of Fe^{+3} salicylate complex by jobs and mode ratio method
7. Stoichiometry and stability of Fe^{+3} thiocyanate complex by jobs and mode ratio method

B. Flame photometry (Any Two)

1. Estimation of sodium
2. Estimation of potassium
3. Estimation of calcium
4. Estimation of Lithium
5. Estimation of Cd^{++} and Mg^{++} in tap water

C. Chromatography (any one)

1. Separation of Cd^{++} and Zn^{++} by paper chromatography. Determine its Rf value.
2. Separation of Ni^{++} and, Co by paper chromatography. Determine their Rf value.
3. Separation of Cd^{++} and Zn^{++} by TLC. Determine their Rf value.

Books Suggested:

- 1) Structural methods in Inorganic Chemistry by E.A.V. Ebsworth.
- 2) Physico chemical methods in Inorganic Chemistry by Drago
- 3) Inorganic Experiments – J. Derek, woo

M. Sc. Second Year
Laboratory Course-VII, Paper- XXVII, CH-503

Marks: 4 Credits

Periods: 132

A] Metal estimations: Volumetric / gravimetric (Any Six)

Alloys/ores/drugs/paints/edibles

1. Estimation of metal ions in coins
2. Estimation of metal ions in Bauxite ore
3. Estimation of metal ions in Pyrolusite ore.
4. Estimation of Lead in red paints (Lead borate)
5. Estimation of calcium and magnesium in talcum powder
6. Estimation of Aluminium from its ore.
7. Estimation of calcium from drug sample .
8. Estimation of metal ions in cement
9. Estimation of metal ions in fruits

B] Structural interpretation (Any one from each section)

1. LFT

1. Indicate the splitting of the d-levels and the number of electrons in each level for each of the following complexes.

- a) $\text{Ni}(\text{NH}_3)_6^{+2}$ (Paramagnetic)
- b) $\text{Trans-Ni}(\text{CH}_3)_4\text{Cl}_2$ (Paramagnetic, tetragonal, Δ for $\text{NH}_3 > \text{Cl}^-$)
- c) $\text{Cu}(\text{NH}_3)_4^{+2}$
- d) $\text{Trans-Ni}(\text{CN})_4(\text{H}_2\text{O})_2^{-2}$
- e) NiCl_4^{-2} (tetrahedral)
- f) $\text{Mn}(\text{acac})_3$ (acac = acetylacetonate)
- g) $\text{Cr}(\text{CN})_6^{-3}$
- h) FeO_4^{-2} (tetrahedral)
- i) CuCl_4^{-2} (tetrahedral)
- j) $\text{Co}(\text{NH}_3)_6^{+2}$

2. Of the complexes in a, e, f, g, h, i and j above, which would you expect to be distorted?

3. Compare the CFSE in $\text{Co}(\text{NH}_3)_6^{+2}$ and $\text{Co}(\text{NH}_3)_6^{+3}$

4. **A.** Calculate the relative energies as a function of Dq and P for both the high spin (HS) and low spin (LS) octahedral and HS tetrahedral aquo complexes of $\text{Co}(\text{II})$ and $\text{Fe}(\text{II})$. On the basis of these calculations state which configuration is the most energetically favorable for each of these ions.

B. On the basis of the CFSE's alone, predict which ion should show the greater tendency form tetrahedral complexes.

C. Is this prediction upheld by the calculations made above and if not, why?

II MAGNETIC CHEMISTRY

1. **a.** $\text{Co}(\text{N}_2\text{H}_4)_2\text{Cl}_2$ has a magnetic moment of 3.9 BM. Is hydrazine bidentate? Propose a structure.

b. How could electronic spectroscopy be employed to support the conclusion in **a.**

2. In which of the following tetrahedral complexes would you expect contributions from spin orbit coupling? V^{+3} , Cr^{+3} , Cu^{+3} , Co^{+2} , Fe^{+2} , Mn^{+2}

3. In which of the following spin-paired square planar complexes would you expect contributions? d^2 , d^3 , d^4 , d^5 , d^6

4. Why is $\text{Fe}_2(\text{CO})_9$ with three bridging and six terminal carbonyl is diamagnetic?
5. Explain why mixing of a D_{4h} component in with T_d ground state lowers the moment nickel (II) complexes.
6. What is expected magnetic moment for Er^{+3} ?

III INTERPRETATION EXERCISES

1. X-ray powder diffraction analysis of cubic compound
 - a. Determination of lattice constants and geometry
 - b. Partical Size
 - c. Density
2. Interpretation of Mossbauer spectrum with reference to determination of a) isomer shift b) quadruple splitting c) Internal magnetic field d) general comment (Problems 7.1 to 7.6.)
3. Interpretation of IR / Raman spectrum with reference to stretching vibration 0-2 C=N, C=O, N-, M-O Problems 5.9 to 5.15
(The spectrum of $\text{Co}(\text{NH}_3)_6(\text{ClO}_4)_3$ has absorption bands at 3320 cm^{-1} , 3240 cm^{-1} , 1630 cm^{-1} , 1352 cm^{-1} , and 803 cm^{-1} . For purposes of assignment the molecule can be treated as a C_{3v} molecule. Use the V_n symbolism to label the bands and also describe them as bends, stretches etc.
4. Interpretation of NMR spectrum with reference to calculation of chemical shifts and general comments.
5. Interpretation of absorption spectra for
 - a. Verification of position of ligands in spectrochemical series.
 - b. Determination of geometry (Octahedral, square planer, tetrahedral) of a given compound.
 - c. Calculation of spectral splitting parameters.
6. Interpretation of polar gram for determination of half wave potentials and unknown Concentration.

BOOKS SUGGESTED:

1. Analytical Chemistry – G. D. Christians, J. Wiley
2. Fundamentals of analytical Chemistry – D. A. Smog, C. N. West and F. J. Holler, W. B. Saunders
3. Analytical Chemistry, principles, J. H. Kenedy, W. B, Saunders
4. Principles of Instrumental Analysis, D. A. Skoog, W. B. Saunders
5. Basic concepts of analytical. Chemistry – S. M. Khopkar, Wiley Eastern
6. Quantitative analysis – R. A. Day, Jr and A. L. Underwood, Prentice Hall

M. Sc. Second Year
Laboratory Course-VIII, Paper– XXVIII, CH-504

Project

Marks: (3+1) Credits

Periods: 132

The students will develop utilities such as analytical spectra, simulation programmes that will supplement laboratory exercises in their subject of specialization. For this, variety of small research project designed by the teacher based on the interest of the student and capabilities should be worked out.

The students will have to give at least one seminar in each semester in their subject of specialization. For this, submission of synopsis of seminar delivered by every student is compulsory which is to be produced before examiner of practical examination.